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Manure Management for Open Lot Livestock Production



USDA Natural Resources Conservation Service
Iowa State University Extension
Iowa Department of Natural Resources
in cooperation with
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It's good business

Handling, storing and application of manure can be environmentally and economically sound. Choosing the right system for your operation and proper management are key to being satisfied with your manure management facility.

This book provides information about components of manure management systems for open feedlots. It is designed to help you choose a manure management system that is effective for storing, handling and making the best use of animal manure.

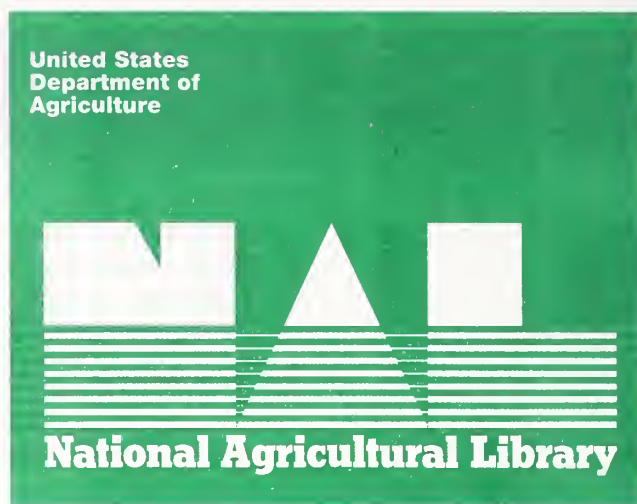
Using the nutrients from animal manure is good business. Monitoring the amount of nutrients being put on the land, and taking credit for them by reducing commercial fertilizers accordingly, takes full advantage of a manure management system. Taking full advantage of the nutrients helps make the system cost effective and will help the environment.

Proper manure management can go a long way in improving water quality. Manure that isn't retained generally has the potential to reach a water body unfiltered.

With a well designed manure management system, you'll have more opportunities to properly apply and use the manure. A well managed system can also help reduce odor.

Legislation is another consideration in manure management. State and federal legislation regulates manure management on different size operations and may be more restrictive in environmentally sensitive areas of the country. Don't forget to check regulations that may apply to your operation.

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manure tests lead to optimum use of the nutrients from animal manure.

Bottom: Animal manure applied to cropland reduces the need for commercial fertilizer. Proper application means more profit and a better environment.



Choosing a system

When choosing a manure management system, there are several questions you have to answer. There are advantages and disadvantages for every system—you have to decide which system will work best for your operation. Here are some items to consider:

Evaluate the manure handling equipment you'll use.

- ? Do you want to change from your current equipment?
- ? What will work best for your operation—liquid, semi-solid or solid waste?

Decide if you need to store and dispose of all the wastes coming from your feedlot, or if settling the solids and releasing the liquids will be adequate.

Here are some considerations:

- Complete control, which means to store and dispose of all runoff from the feedlot plus the manure solids and liquids, is sometimes required by state and local regulations.
- Complete control of all runoff should be considered when your operation is located where runoff could pollute a nearby stream or other body of water.
- Swine manure solids don't settle readily. Dairy and beef manure is drier and solids settle out quicker than swine manure. Pages 5 and 6 give information on different manure handling methods.

Decide how long you need to store manure.

- ? How often and at what times of the year do you want to dispose of the manure and runoff stored in your manure management system.
- While building smaller storage areas lowers construction costs, these systems must be emptied more often.
- Reduce the amount of storage needed by diverting clean water from adjacent fields or roofs away from the feedlot area. See page 8.
- Systems that only settle solids require more frequent hauling. These storage systems should be emptied after every major rainfall.
- A minimum of three to four months of storage must be provided to allow for storage until field conditions are right for application. In some cases, state or local regulations may set minimum storage requirements. Beyond that, storage requirements depend on how much land is available and when you can apply manure. If you don't have land available, you'll need to find cropland to spread manure. Some state and local agencies that issue permits require an agreement with a landowner that ensures the permit recipient has enough land to spread manure before issuing the permit. (Permit requirements vary from state to state. Check regulations before building.)

Top right: The earthen storage pond is an inexpensive storage facility.

Bottom right: Pumping is one way to move manure to storage and from storage to application.

Decide what type of storage facility you'll use.

Storage systems are usually earthen waste storage ponds, concrete, or corrosion resistant metal structures. After determining which material to use, you'll have to decide whether you want the system to be above or below ground. Some deciding factors include:

- ✓ cost
- ✓ soil type
- ✓ size of operation
- ✓ permit restrictions
- ✓ odor control

Decide how you'll deliver the manure to the storage facility.

- ? Can you use gravity to move manure to the storage facility?
- ? Will you have to chop bedding to allow adequate movement of manure to the storage facility?
- ? Do you have to consider sand when pumping? Sand can be hard on pumping equipment.
- ? Will you be using flushing water?



Choosing a system



An auger built into the manure storage facility allows easy loading for application for this producer.

Decide how you'll empty the storage facility, and if you'll need to agitate the manure.

- Earthen storage structures that contain manure solids generally need concrete agitation pads. You'll have to provide space enough for the tractor to sit flat. This will prevent excess wear on the tractor engine.
- Agitation is often necessary. Most agitators can only reach 80 feet—if the pit is longer, agitate at both ends. Check with other operators who have experience emptying pits. The pump is a big investment, and you'll want to be sure what you buy will get the job done.
- In an earthen basin, it's ideal to have the sump lower than the basin. It's also important to have a concrete pad on the floor of the basin to eliminate scouring from agitation.
- Additives are available that may help liquefy solids so you can pump them. Some of these additives may reduce odor as well.
- ? Do you need a ramp to get in and out of the storage area?

Manure management facilities can be built from a variety of materials. Here are a few examples of materials and what to consider when using the materials.

- ✓ concrete or prefabricated concrete are popular.
- ✓ prefabricated metal is durable, but often more expensive than other materials.
- ✓ earthen ponds and settling basins are popular, but are often restricted on some soil types and in some locations. A liner may sometimes be used with an earthen pond to keep manure from leaching. Once again, check state and local regulations.
- ✓ wood can be used, but has a short longevity.

Often times, a combination of materials will work best.

A note on safety:

Open manure pits can be a safety hazard. Be sure to take precautions, especially when children will be around the area. Concrete covers can be made for rectangular tanks. You should always have a barrier or fence around the area.

How to use this guide

This guide is laid out to cover each stage of manure management. It is intended to show you options that farmers have used. There are some parts of systems that won't work together, but often times, you can take several features you like and make a system that fits your operation.

The stages of manure management covered are:

- Storing manure
- Settling solids
- Releasing liquids
- Treating runoff
- Manure transfer to storage
- Manure transfer from storage
- Storage to application
- Applying nutrients to the land

Each section has several options listed. Under each photo you'll see a "+" and a "-". Beside the "+" sign, advantages of using that option are listed.

Beside the "-" sign, disadvantages are listed. Following a "•" is additional information about the option that is neither an advantage or a disadvantage, but something to think about.

In the back of the pamphlet are a few complete manure management systems. You'll be able to see how a few farmers put items together to fit their operation.

Storing manure

Earthen pond



Earthen waste storage ponds can be used to provide short term storage of both manure solids and runoff liquids, or to store runoff liquid draining from a solids settling facility. If both solids and liquids are stored, the pond will probably have to be agitated before disposal. You must pump the pond out at least once each year, but it will likely need pumped twice depending on pond size and regulations.

- + Less expensive to construct than concrete or steel.
- Seepage may be a concern
- Must maintain vegetation around the pond.
- Weeds are often unsightly.
- Check depth to bedrock and water table. Certain soil types prohibit use of an earthen pond.
- Can not be used below the water table unless adequate drainage is provided.

Concrete lined basin



Concrete lined basins

- + Can be used where distance to bedrock is shallow.
- + Can include a ramp to allow equipment to be driven into pond for cleanout.
- May be difficult to place concrete on steep slope.
- Difficult to cover.
- Can not be used below the water table unless adequate drainage is provided.

Round concrete tank



Round concrete tank

- + Less expensive per unit storage than rectangular tanks.
- + Interior wall supports not needed after construction due to shape.
- + No corners to accumulate solids.
- + Most volume in smallest area.
- Can't drive equipment into tank.
- Must provide for drainage around outside.

Lagoon



A lagoon is similar to an earthen pond, but is used for treating manure. Bacterial activity occurs in a lagoon.

- + Reduces the amount of land required for spreading.
- + Minimizes potential for water pollution downstream.
- Large volume of liquid to be disposed of annually.
- Large volume of clean water needed to begin operation.
- Reduces nutrients for land application.
- Phosphorus accumulates in sludge.
- Can not be used below the water table unless adequate drainage is provided.

Rectangular concrete tank



Rectangular concrete tank

- + May fit into livestock lot better than a round tank.
- + May be easier to cover than ponds, lagoons or round tanks.
- + May be designed to be installed under a building or slatted floor.
- Will need a wall support system designed as part of the tank or lid.
- Solids can accumulate in corners.
- Can't drive equipment into tank unless ramp is built. (ramp will add expense and reduce storage)
- Must provide drainage around outside.

Prefabricated metal tank



Several types of prefabricated slurry storage tanks are available.

- + Structural designs are available from manufacturers.
- Generally more expensive than other alternatives.
- Other considerations similar to round concrete tank.
- Can be above or below ground.

Settling solids

Earthen sediment basin



Earthen sediment basin

- + Least expensive sediment basin to construct.
- May have higher operation and maintenance costs than other types of basins.
- Complete cleaning not possible without concrete floor.
- Concrete floor is recommended for cleanout.

Concrete sediment basin



Concrete sediment basin

- + Longest life expectancy of all basins.
- + Most adaptable to confined areas.
- + Can be cleaned thoroughly.
- More expensive than earthen sediment basin.

Wood wall sediment basin



Wood wall sediment basin

- + May be relatively inexpensive to construct.
- + Easy to make adjustments for management purposes.
- Maintenance will be greater than for concrete basins.
- Locally grown material may be available.

Stacking facility



Stacking facility

- + Allows accumulation of solids for timely application.
- + Relatively inexpensive method of separating liquids from solids.
- Materials leached from facility may become a pollutant if not controlled.
- Must have lot conditions or use bedding which would allow this system to work.

Solids settling terraces



Solids settling terraces may be located in feedlots or below the lot.

- + Remove solids from liquids.
- + Extra area outside lot not necessary for in lot terraces.
- Frequent maintenance needed to remove solids and reshape terraces.
- May not be desirable to create sediment traps in lots where live-stock are kept.
- Concrete base may be needed to facilitate cleanout.

Releasing liquids

There are many ways to release liquids slowly to allow additional time for solids to separate from liquids.

Horizontal stop log



Horizontal stop logs allow liquids to separate from solids.

- + Easy to construct.
- + Easy to remove individual planks to allow liquid to move quickly for cleanout.
- No flow when slots are blocked between gaps.
- High maintenance.
- Gaps tend to plug easily.
- Recommend each operator adjust slot gap to find what works best for their system.

Vertical stop log



Vertical stop logs allow liquids to flow through slats and leave solids.

- + Easy to construct.
- + Liquids will flow through slots at any depth.
- High maintenance.
- Must be cleaned out regularly.
- Recommend each operator adjust slot gap to find what works best for their system.

Intake with barrier



Perforated pipe intake

- + Uses underground pipe system if the desired outlet is not directly adjacent to the settling facility.
- + Easy to construct.
- + Flows at any depth.
- + Barrier protects intake.
- More difficult to clean than pipe without barrier.
- Intake volume not flexible. Maximum amount allowed to flow is limited by capacity of intake.
- High maintenance.



Left: Horizontal stop logs release liquids from settled solids. The main difference between horizontal stop logs and vertical stop logs (above) is the vertical logs release liquids at every depth. Horizontal logs are like small dams and release liquids at different depths. On both structures, producers have to experiment with the gaps in the slats to find what works best for their system.



Treating runoff

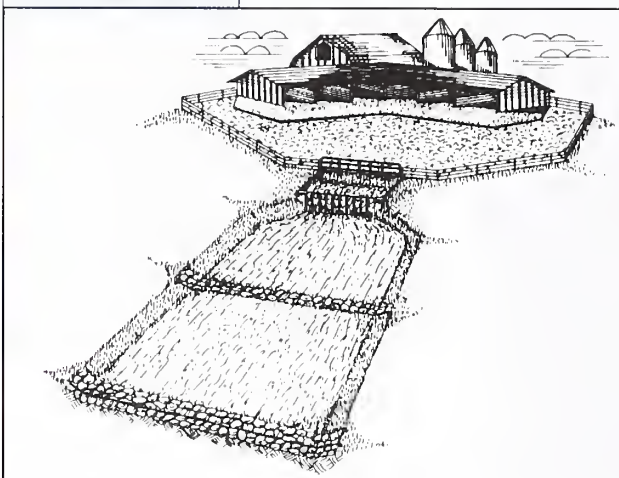
Filter strip



Grassed filter strips are used when retention of all runoff liquids is not required by state or local regulations and the potential for pollution is low. Liquids draining from a solids settling basin may be discharged to a grassed filter strip.

- + Inexpensive to install.
- + Removes some solids from liquids.
- Maintenance not easy.
- Channelized flow commonly occurs and reduces effectiveness.
- Usually needs to be fairly long.
- Bottom needs to be flat to function properly.

Level spreader



Level spreader is used to eliminate channelized flow in a filter strip.

- + Helps reduce the maintenance requirements for a filter strip.
- + Helps maintain sheet flow in a filter strip.
- + Improves effectiveness of a filter strip.

Redirecting runoff

Clean water runoff from the farmstead can often end up in a manure storage facility if the water isn't redirected. Diversions redirect water around storage area.

Eaves



Eaves, troughs or rain gutters are used to capture runoff from the roof of livestock buildings.

- + Runoff water is channeled away from the manure storage area so storage capacity in storage areas is not reduced.
- + Reduces total storage requirements of storage facility.
- Ice can plug and damage eaves.
- Extra cost for installation.

Clean water diversion



Clean water diversions are used to divert clean runoff water around the feedlot or manure storage area.

- + Reduces the amount of water that enters the storage area. Clean water diversions are especially helpful if the feedlot is at the bottom of a hill.
- May leave ridges in farmstead area that are undesirable.
- Concrete curbs along lot lines also serve as diversion.

Manure transfer to storage

When installing a manure storage structure, manure transfer is a major consideration. First decide how you'll transfer manure from the livestock facility to storage and then from storage to the field.

Bedding type, flush water, and distance to storage must be addressed.

Pump



- + The storage can be level with or uphill from the livestock facility.
- + More bedding options are available; long straw, sand, sawdust, wood shavings can be used.
- There will be maintenance expenses.
- A piston pump will transfer semi-solid manure with bedding.

Push off wall



Push off walls may be used to transfer manure from settling basins, lots or directly from housing to a storage area.

- + No maintenance of pumping equipment.
- + Any type of bedding may be used.
- System may not work as well if the manure is too runny.
- Manure may pile at base of wall.
- Safety hazard—equipment can fall over wall.
- If a push off wall is used, safety measures such as safety cables must be installed to prevent equipment from falling into the storage area.

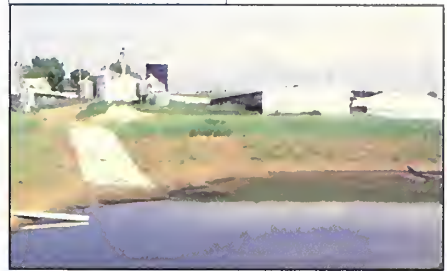
Reinforced concrete pipe



Reinforced concrete pipe can be used with gravity pipelines for solids. PVC pipe is also an option.

- + Generally have a longer life than metal pipes.
- For dairy operations, straw must be chopped.
- If you use this transfer method, milk house water should be outletted directly into the gutters or into a storage area.
- For hog operations, a pull plug should be used to prevent liquid solid separation.

Push-in ramp



Concrete ramps may be used with waste storage ponds for equipment access or to push in manure from settling basins, lots or directly from housing.

- + No maintenance of pumping equipment.
- + Any type of bedding may be used.
- In the winter, the manure tends to pile up and part of the storage area may become unusable.
- Traction may be a problem with steep ramps.

Gravity flow pipe



Gravity flow can be used to transfer liquid or semi-solid manure to storage. Manure is either continuous flow or a pull plug is provided.

- Prevent frozen manure from entering the system. Temporary storage must be housed or kept warm enough to prevent freezing.
- With continuous flow, the outlet should be covered with manure to prevent freezing. Outletting into a sump area is recommended.
- If the outlet pipe can be placed at or near the bottom of storage—odor is reduced.
- In an earthen structure, if the outlet is not at the bottom, installing concrete or rock will prevent scouring near the outlet of the pipe.

Inlet to storage



- Inlets above liquid level are subject to freezing.
- Freezing may cause damage to exposed pipes. Submerged pipes may be subject to plugging.
- Inlets should extend far enough into storage facility to avoid bank erosion.
- Consider protecting the slope when an outlet is above the liquid level.

Manure transfer from storage

There are many options for transferring manure from the storage area and options for manure application. The next three pages show ways to move manure from storage to application and ways to apply manure to the land.

Cost of equipment, horsepower needed to run equipment, time of year the application will occur, distance to the application site and time and labor available for application should be taken into consideration when deciding on what will work for you.

Agitator



Agitation is typically used when manure is handled as a liquid.

- + Agitation will mix liquids and solids providing more uniform nutrients during application.
- + Prevents solids build up in corners and on the bottom.
- In an earthen facility, a concrete agitation pad at least 10 feet X 10 feet should be installed to prevent the agitation pump from scouring the bottom.
- Agitation areas should be recessed in a sump area to enhance manure flow to the pump. If the top width of the storage area is wider than 80 feet it is recommended to agitate from both sides for adequate mixing.

Pad for pumpout



A pad may be installed to allow for easier pumpout.

- + Makes pumpout easier.
- + May reduce maintenance for pump.
- + Pad provides a level area for tractor, which may be easier on the equipment.

Pump



A pump is used to transfer liquid manure to tank wagons or to irrigation equipment. The pump works better if placed in a sump area.

- + Fast and easy to use.
- High maintenance.
- Does not work well with solid and semi-solid manure.
- Can require high investment.

Corrugated metal pipe pumpout structure

Corrugated metal pipe pumpout structure is used as an alternative to the pad for pumping out waste storage ponds.

- Less initial cost than concrete.
- Shorter life than concrete.
- Not convenient for agitation of pond.

Poured concrete sump pumpout structure



A sump pumpout allows more complete emptying of storage.

Ramp



A ramp provides access into the storage area to load out manure as a solid.

- + No maintenance of mechanical equipment.
- May require removal of liquids prior to and during loading.

Manure transfer from storage

Auger



An auger can be used to transfer solid or semi-solid manure. The auger should be placed in a sump area.

- + Smaller amounts of manure can be emptied.
- + Agitation is not always required.
- + Manure can be removed without breaking crust.
- High maintenance required.

Commercial services



Commercial services are available to empty storage tanks and to spread manure.

- + No maintenance of equipment.
- + No large initial investment.
- Equipment may not be available when producer is ready for application. Timing is not always optimal for crops and tillage conditions.
- You should discuss your waste utilization and nutrient management plan with the commercial service manager to ensure proper application.

Gravity flow



Occasionally a storage area can be unloaded by opening a valve and filling a liquid tank wagon by gravity flowing manure. Agitation may still be necessary.

- + No maintenance of mechanical unloading equipment.
- + Fast unloading
- Potential environmental hazard if valves fail. . . always have two.
- Must be located on a hillside.
- Gravity flow systems will work under specific circumstances. Use is restrictive. This practice may not be approved by state regulatory agencies.

Applying nutrients to the land

Manure spreader



The manure spreader is used for solids and thick slurries.

- + Relatively inexpensive.
- + Low maintenance.
- Manure cannot be runny.
- Hard to apply uniformly.
- Small loads take longer to empty.
- Requires loading equipment.

Flexible drag hose



The flexible drag hose is a quick way to apply manure, if you have a relatively flat landscape.

- + Unload quickly.
- + Eliminates compaction by liquid tank wagon.
- Requires three tractors, or two tractors and a power unit on the pump.
- Doesn't work well on irregular shaped fields or land.
- Equipment is expensive.
- Some custom spreaders use this system.

Big gun irrigation sprinkler



The big gun irrigation sprinkler shoots liquid manure onto the land. It may be used for nearly any volume of liquid and is especially useful when large volumes are applied to the land.

- + Big guns can be used when there is a crop canopy, however high nutrient concentrations may cause crop damage.
- + Application can be done quickly.
- + No compaction from heavy loads.
- Odor may be a problem when using the big gun.
- Distance from facility to field is usually limited.
- Equipment is expensive and fairly high maintenance.
- Good management and operation is required to ensure proper nutrient application.

Incorporation implement



There are several incorporation implements. Implements include tank wagons with knives or other incorporation attachment, disk, harrow, etc. Be sure you take crop residue levels into account when you're incorporating manure—don't bury too much residue.

Tank wagon



Tank wagons are used for liquid manure.

- + Adaptable to either surface broadcast or injection.
- + Easier than manure spreader to get uniform application.
- + Self loading.
- + No additional pumps required.
- Horse power requirements and soil compaction may be significant.
- May take longer to empty facility.
- Many tank wagons are equipped with locking pumps.

Tank wagon with knives



Tank wagon with injection knives

- + Can reduce nutrient losses.
- + Less odor during application than with other systems
- Requires more power than other systems.
- High concentrations of nutrients found in knife zone. Using a sweep injector can reduce concentrations.
- May not be compatible with crop residue requirements.
- Cropland surface left rough after injection.

Putting it all together

Kirk and Lisa Snitker
Allamakee County

Operation:

575 farrow to finish swine
50 head Holstein cows

Manure management system:

The Snitkers' manure storage facility is designed to pump gutter manure from the dairy barn and provide storage for runoff and manure scraped from the hog lots.

The earthen storage structure is built off the south edge of the hog lot. Gutter manure is pumped from the dairy barn.

Snitker installed an Acorn manure pump and 12" PVC delivery pipe to transfer manure from the dairy barn. One advantage of storing hog manure with cattle manure is the cattle manure tends to crust over which significantly reduces the odor of the hog manure during storage.

Manure from the hog lots is scraped into the pit once a week. Rain gutters on Snitker's hog lot roof reduce excess runoff. A diversion was built to divert farmstead runoff from the storage area.

The earth storage facility is designed to store about 8 month's of cattle and hog manure, plus runoff from the lot.

The bottom and sides of the earth structure are lined with concrete because there is not much depth to bedrock. The liner also keeps the bottom from scouring during agitation, and a skid loader could be used for final cleanout.

Snitker handles the manure as a liquid which is best for gutter manure mixed with hog lot runoff.

Snitker agitates the pit manure and loads it into a honey wagon. It takes about 30 hours to empty the manure pit.



Top: Manure is scraped into the concrete lined storage pond from the hog lots and dairy manure is pumped into the storage pond from the dairy barn shown in the upper right corner of the photo.

Center: The dairy manure forms a crust on the pond which reduces odor from the swine manure.

Left: Eaves catch excess runoff water. The excess water is channeled away from the storage area.

Putting it all together

Cutting Edge

Dennis Leith, manager
Union County

Operation:

500 head calves & bulls
(average weight 900 pounds)

Manure management system:

Below the four acre cattle feedlot, Dennis installed a sediment basin to settle solids and a waste storage pond to hold liquids.

The sediment basin has a concrete slab which grades toward an 8 inch PVC intake. The intake is surrounded with a wooden trash rack to prevent solids from plugging the intake.

A 3 feet concrete wall was installed on one end to push up against when cleaning the sediment basin.

The intake pipe drains into another 8 inch PVC pipe. That pipe splits to outlet at two different elevations into the storage pond.

The waste storage pond has enough storage for runoff from the paved and unpaved feedlot areas for the period between emptying, plus runoff from a 25-year, 24-hour storm. Both the sediment basin and the waste storage pond have emergency spillways.

Two diversions were built below the feedlot to ensure all feedlot runoff is channeled to the sediment basin. Another diversion diverts clean water away from the emergency spillway of the waste storage pond.

Dennis empties the waste storage pond by using a pit type chopper pump which he lowers into a 48" concrete manhole. This manhole has an 18" concrete pipe which extends into the bottom of the pond.

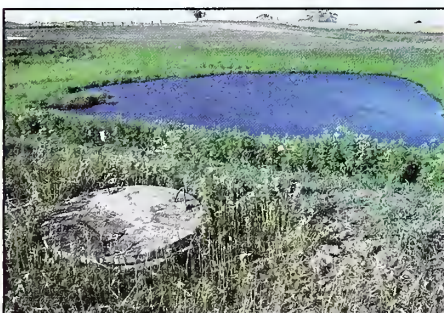
This facility was designed with expansion in mind. Dennis plans to roof an area above the feed bunks. At that time, he'll install gutters that will channel clean runoff from the roof to an underground tile, reducing the runoff to the storage pond.

Top: System includes feedlot, sediment basin with concrete and storage pond.

Left center: Intake allows liquids to run into storage pond.

Bottom left: Manhole in foreground is used for emptying storage pond.

Bottom right: Flags show outlet pipes at two elevations.



Putting it all together

Richard, Ruth and Adam Quandahl
Allamakee County

Operation:

80 head Holstein milk cows

15 head replacement heifers

Manure management system:

The Quandahls installed a concrete wall settling basin with wooden plank stoplogs. The storage areas behind the stoplogs are designed to handle half of the runoff from a 10 year 1 hour storm (2.1 inches) plus one month's accumulated manure storage.

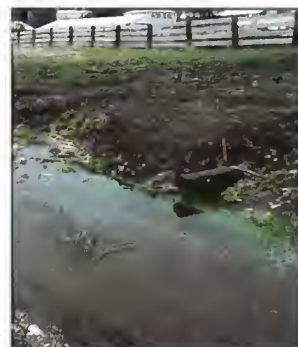
Excess runoff will run over the top of the stoplog setup. Vertical stoplogs minimize the amount of liquid backed up behind the stoplog. Double stop logs were installed to further settle out solids.

Clean water runoff from the buildings and farmstead is diverted from the lots by the raised driveway serving as a diversion. The farmstead runoff is drained to underground culverts. These culverts then deliver the water to clean water channels which flow to a nearby stream.

In addition to the diversion, roof gutters keep clean water runoff from buildings off the lots which reduces manure runoff.

Filter strips below the stoplog arrangement use grass to filter nutrients from the liquids before they reach the stream. These grassed areas also serve as buffers between the other earthen lots and the stream.

The stream corridor below the lots is fenced off and seeded down to limit livestock access to the stream.



Top: This manure management system uses a combination of a prefabricated metal storage tank for dairy barn manure and a horizontal stoplog structure to settle solids in the feedlot.

Left center: Eaves catch clean runoff water which is carried to a culvert and delivered to the stream.

Right center: Clean water from eaves and from farmstead runoff above the feedlot is delivered through this culvert.

Bottom left: Liquid manure from the milking parlor and solids from the freestall barn and the open lots is pushed into the concrete pit and pumped into metal tank.

Bottom right: Two sets of stop logs release liquids that are filtered before they reach the stream below.



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